هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAA
2024
TP-153

Course Specification
(Bachelor)

Course Title: :	Atomic Physics
Course Code:	PHY 1462
Program:	Bachelor of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	4
Last Revision Date:	*26/09/2024*

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A. General information about the course:

1. Course Identification

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (Level 7/ Year 4)					

4. Course General Description:

Using the quantum approach to the subject of atomic physics, this course keeps the mathematics to the minimum needed for a clear and comprehensive understanding of the material. Beginning with an introduction and treatment of atomic structure, the course goes on to deal with quantum mechanics, atomic spectra and the theory of interaction between atoms and radiation. This course covers the following topics: the hydrogen atom, the hydrogen atom-fine structure, two-electron atoms, many-electron atoms, interaction with static external fields, interaction with static external fields, and hyperfine structure.

5. Pre-requirements for this course (if any)**:**

Quantum Mechanics (2), PHY 1313

6. Co-requisites for this course (if any)**:**

7. Course Main Objective(s):

- **Understand the concepts of a good quantum number and simultaneous observability.**
- **Understand the quantum numbers, including their physical significance, and quantum mechanical states of the hydrogen atom.**
- **Understand time independent perturbation theory including its derivation and be able to apply it to simple systems, including the Stark-Effect and Zeeman Effect.**
- **Know about the origins of fine structure in atomic spectra.**
- **Understand the exchange degeneracy and how this affects the excited states of helium.**
- **Understand the Periodic table from the viewpoint of the electronic structure.**
- **Understand and be able to apply to simple cases time dependent perturbation theory.**
- **Understand the derivation of and be able to apply the selection rules for the interaction of electric dipole radiation and atoms.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	30
5.	**Others (specify)**	0
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	**State the basic principles of quantum mechanics in the physics of atoms.**	**K1, K2**	• Lectures. • Tutorials. Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the basic concepts related to atomic structure and atomic features.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Outline the basic concepts of interaction between atom and electric and magnetic field.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	Skills			
2.1	**Explain and summarize the basic knowledge**	**S1, S2**	▪ Lectures. ▪ Class discussions. ▪ Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	gained from studying the course.			
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	▪ Problem classes and group tutorial. ▪ Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. Office hours.	▪ Participation. ▪ Homework. Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**The hydrogen atom:** The Schrödinger equation, Stationary states, Expectation values, Solution of Schrödinger's equation for a Coulomb field, The quantum numbers ℓ and m_ℓ, The hydrogen energy spectrum.	**12**
2.	**The hydrogen atom-fine structure:** Electron spin, The interaction terms, The vector model, The Lamb shift.	**8**
3.	**Two-electron atoms:** Electrostatic interaction and exchange degeneracy, The ground state of helium, The excited states of helium, Electron spin functions and the Pauli exclusion principle, The periodic system.	**10**
4.	**Many-electron atoms:** The central field, Thomas-Fermi potential, The LS coupling approximation, allowed terms in LS coupling, Fine structure in LS coupling, The j-j coupling approximation.	**10**
5.	**Interaction with static external fields:** Zeeman effect in LS coupling, Quadratic Stark effect, Linear Stark effect.	**10**
6.	**Hyperfine structure:** Magnetic dipole interaction, Determination of nuclear spin from magnetic hyperfine structure, Determination of μ_I from magnetic hyperfine structure, Magnetic hyperfine structure in two-electron	**10**

	spectra, Electric quadrupole interaction, Zeeman effect of hyperfine structure.	
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.…..)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**6thweek**	**25 %**
3.	**Midterm Exam 2**	**12thweek**	**25 %**
4.	**Final Exam**	**16thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Woodgate G. K., ***Elementary Atomic Structure,*** McGraw-Hill (1983).
Supportive References	- Jones D. G. C. ***Atomic Physics,*** Chapman and Hall (1997). Foot C.J., ***Atomic Physics,*** Oxford (2005).
Electronic Materials	- **https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- **Classrooms.** - **Labs.**
Technology equipment (projector, smart board, software)	- **Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- Students - Second examiner	- Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)
Effectiveness of Students assessment	- Instructors	- Direct (exams, HW, project, …)
Quality of learning resources	- Faculty - Students	- Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	- Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024